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Dated 17 December 2003

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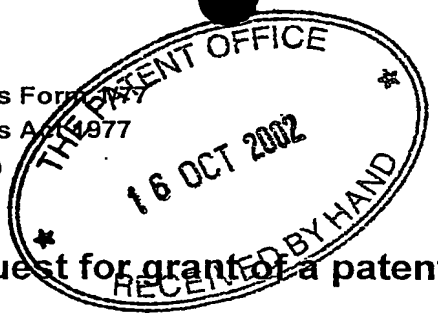


The Patent Office

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P01/7700 0.00-0224090.1

# Request for grant of a patent

The Patent Office
Cardiff Road
Newport
South Wales NP10 8QQ

1. Your reference
**1886401/DJBB**

2. Patent Application Number 16 OCT 2002 0224090.1

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

**Sensopad Technologies Limited**
**Harston Mill**
**Harston**
**Cambridgeshire**
**CB2 5GG**

Patents ADP number *(if known)* 08486003001

If the applicant is a corporate body, give the country/state of its incorporation Country: **England**

4. Title of the invention

**SENSING APPARATUS & METHOD**

5. Name of agent **Beresford & Co**

"Address for Service" in the United Kingdom to which all correspondence should be sent

**2/5 Warwick Court**
**High Holborn**
**London WC1R 5DH**

Patents ADP number 00001826001

6. Priority details

| Country | Priority application number | Date of filing |
|---|---|---|

## Patents Form 1/77

7. If this application is divided or otherwise derived from an earlier UK application give details

Number of earlier application | Date of filing

8. Is a statement of inventorship and or right to grant of a patent required in support of this request?

Yes

9. Enter the number of sheets for any of the following items you are filing with this form.

| | |
|---|---|
| Continuation sheets of this form | 0 |
| Description | 2 |
| Claim(s) | 0 |
| Abstract | 0 |
| Drawing(s) | 0 |

10. If you are also filing any of the following, state how many against each item.

| | |
|---|---|
| Priority documents | 0 |
| Translations of priority documents | 0 |
| Statement of inventorship and right to grant of a patent *(Patents form 7/77)* | 1 + 4 copies |
| Request for preliminary examination and search *(Patents Form 9/77)* | 0 |
| Request for Substantive Examination *(Patents Form 10/77)* | 0 |
| Any other documents *(please specify)* | 0 |

11. I/We request the grant of a patent on the basis of this application

Signature Beresford & Co Date 16 October 2002

BERESFORD & Co

12. Name and daytime telephone number of person to contact in the United Kingdom

BRINCK; David John Borchardt

Tel: 020 7831 2290

# Sensing Apparatus & Method

## Field

This invention relates to a sensing apparatus and method which has particular but not exclusive relevance to a position sensor for sensing the relative position of two members.

## Prior Art

Various forms of inductive sensor have been used to generate signals indicative of the position of two relatively movable members. Examples include the invention described in UK Patent Application GB-A-2374424 and the invention described in a UK Patent Application filed on even day herewith entitled "Sensing Apparatus and Method", the contents of both these documents being incorporated herein by reference. In such sensors one member carries excitation windings and a sensor winding while the other member carries a resonant circuit. The magnetic coupling between the resonant circuit and the sensor winding varies with position so that by applying an oscillating signal at the resonant frequency of the resonant circuit to the excitation windings, a signal is induced in the sensor winding whose electrical phase is indicative of the relative position of the two members.

One problem with such sensors is that two excitation windings and two sets of excitation electronics is required. This can be problematic in achieving minimal costs when large or long transmit windings are required, which may be expensive to engineer. It is also disadvantageous in some instances to use two sets of excitation electronics, for example in harsh, hazardous or particularly space-constrained environments where minimisation of any electronics is beneficial.

## Invention

This invention enables the use of a single set of transmit electronics and a single transmit winding. The sensor comprises:

- A single excitation winding made up from a sine coil or a cosine coil of wavelength L
- A sensor winding. This generally but not necessarily extends around the excitation winding which may or may not be electromagnetically balanced to far field emissions
- An intermediate passive electrical circuit made from a plurality – most typically two - LC resonant circuits of substantially the same resonant frequency physically spaced apart by L/4 in the measurement and their electrical responses are at 90 degrees to each other
- A frequency generation circuit capable of generating frequencies substantially in the range of the intermediate circuit's resonant frequency
- A receive signal-processing circuit chiefly comprising the elements such as those described in GB-A-2374424 or its copending application

The frequency generation circuit generates an oscillating signal in the excitation winding.

The field produced by the excitation winding induces currents to flow in each of the intermediate circuit's resonators.

Each of the resonators induce signals in the sensor winding whose electrical phase is at –90 degrees to the alternating field produced by the excitation winding. Such a response may be attained by the use of two resonators, which are physically angled at +45 and –45 degrees relative to the plane of the excitation and receive windings.

The phase of the received signals in the sensor winding is generally proportional to X, L and $W_o$ where X is the distance travelled along the excitation winding; L is the wavelength of the excitation winding; $W_o$ is the angular frequency. Such calculations are modified by $\cos(W_1 t)$ if the resonant frequency is modulated by a lower angular frequency of $W_1 t$

Since each of the resonators in the electrical intermediate device are effectively in space quadrature by virtue of their L/4 relative displacement, position ambiguity may be removed whilst still using just one transmit circuit.

The receive electronics filters the received signal; through a low pass filter. From this the distance X may be calculated since the phases of the signal and the wavelength of the excitation circuit is known. This is readily accomplished using zero crossing electronics.

Ideally the resonant frequencies of the resonators are matched. In practice this may be difficult or expensive to achieve and instead a factory calibration may be used.

Alternatively the sensed signal may be used to measure temperature in a constant humidity environment (or humidity in a constant temperature environment) with a spatially fixed intermediate device. Such measurements may be compared to a factory calibration for accurate measurements.

Alternatively rather than arranging the two resonators in space quadrature the resonators may be electrically modified such that the phase response in one resonator is delayed by 90 degrees. This may be achieved by tuning the resonant frequencies above and below the excitation frequency and exciting at a middle frequency. Although theoretically possible this is not as preferred as simply spacing the resonators in space quadrature.

In order to negate the effects of breakthrough or noise the generation frequency can drive the generation circuits at an 'off frequency', which is significantly above or below the resonant frequency (outside the bandwidth of the resonators) such that background noise may be calculated and subtracted from the signals when driven at resonant frequency. This need only be carried out intermittently.

PCT Application

GB0304504